



**US Army Corps  
of Engineers**

Construction Engineering  
Research Laboratories

USACERL Technical Report-95/06  
June 1995

# **Munitions Production Waste Generation at Army Installations: A Survey**

by  
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A significant amount of energetic material waste (EM) and solid waste contaminated with energetic material (EMCW) is generated by U.S. Army installations that manufacture munitions. Disposal of this waste and outdated ammunition has to comply with Federal, state, and local regulations; and regulations vary significantly from state to state. Most munitions waste has been disposed of by open burning (OB) or open detonation (OD). But OB and OD continue to be an environmental concern, and few disposal alternatives have been developed.

The first step in developing alternative disposal methods is to determine the amount of munitions waste generated. This report gives the results of a survey of nine installations for a 5-year period from 1988 to 1992; these results show that wastes from munitions production is significant. The total EM and EMCW generated annually by the nine installations were 1,600 and 6,100 tons, respectively. Although most installations generating EM and EMCW have used OB/OD for energetic waste disposal, some are beginning to use alternative methods. A realistic approach to establishing alternative energetic waste disposal methods can now be formulated based on this study that determined the amounts and types of energetic wastes generated at U.S. Army installations.



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# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave Blank)		2. REPORT DATE June 1995		3. REPORT TYPE AND DATES COVERED Final	
4. TITLE AND SUBTITLE Munitions Production Waste Generation at Army Installations: A Survey				5. FUNDING NUMBERS 4A162721 D048 PE-TH3	
6. AUTHOR(S) Bernard A. Donahue and James M. Stratta					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Construction Engineering Research Laboratories (USACERL) P.O. Box 9005 Champaign, IL 61826-9005				8. PERFORMING ORGANIZATION REPORT NUMBER  TR-95/06	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Environmental Center ATTN: SFIM-AEC-ETD Bldg. E4460, Beal Road APG, MD 21010-5401				10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.					
12a. DISTRIBUTION / AVAILABILITY STATEMENT  Approved for public release; distribution is unlimited.				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)  A significant amount of energetic material waste (EM) and solid waste contaminated with energetic material (EMCW) is generated by U.S. Army installations that manufacture munitions. Disposal of this waste and outdated ammunition has to comply with Federal, state, and local regulations; and regulations vary significantly from state to state. Most munitions waste has been disposed of by open burning (OB) or open detonation (OD). But OB and OD continue to be an environmental concern, and few disposal alternatives have been developed.  The first step in developing alternative disposal methods is to determine the amount of munitions waste generated. This report gives the results of a survey of nine installations for a 5-year period from 1988 to 1992; these results show that wastes from munitions production is significant. The total EM and EMCW generated annually by the nine installations were 1,600 and 6,100 tons, respectively. Although most installations generating EM and EMCW have used OB/OD for energetic waste disposal, some are beginning to use alternative methods. A realistic approach to establishing alternative energetic waste disposal methods can now be formulated based on this study that determined the amounts and types of energetic wastes generated at U.S. Army installations.					
14. SUBJECT TERMS munitions waste disposal Energetic Material Waste (EM) Solid Waste Contaminated with EM (EMCW)  military installations surveys				15. NUMBER OF PAGES 46	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified		20. LIMITATION OF ABSTRACT SAR	

## Executive Summary

United States Army installations that engage in the manufacture of munitions generate a significant amount of waste energetic materials (EM) and solid waste contaminated with energetic materials (EMCW). The majority of these wastes are currently disposed of by open burning (OB) or open detonation (OD) on Army installations. OB and OD activities are of environmental concern and few disposal alternatives have been fully developed.

The results of this study demonstrate that the amounts of EM and EMCW generated from munitions production activities are substantial. Specific EM and EMCW data over the period from 1988 through 1992 for nine AMC installations are contained within this report. The Army installations surveyed included Milan Army Ammunition Plant (AAP), Lake City AAP, Radford AAP, Holston AAP, Lonestar AAP, Iowa AAP, McAlester AAP, Redstone Arsenal, and Crane Army Ammunition Activity (CAAA). These data show that for the nine installations reported, the total amounts of EM and EMCW generated annually were approximately 1,600 tons/year and 6,100 tons/year, respectively.

The environmental regulatory pressures vary significantly for the installations that utilize OB/OD in the disposal of these wastes. Some installations have been forced to develop incineration capacity and some installations experience little regulatory pressure. These pressures are generated primarily by state environmental regulators.

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## Foreword

This study was conducted for the U.S. Army Environmental Center under Project 4A162721D048, "Industrial Operations Pollution Control Technology"; Work Unit PE-TH3, "Alternatives to Open Burning/Open Detonation of Explosives and Energetics." The technical monitor was Wayne Sisk, SFIM-AEC-ETD.

The work was performed by the Troop Installation Operation Division (UL-T) of the Utilities and Industrial Operations Laboratory (UL), U.S. Army Construction Engineering Research Laboratories (USACERL). The research was performed in part by Dr. James M. Stratta of J.M. Stratta and Associates, Inc., Columbus, IN. Special assistance was provided by Robert A. Weber (FL-M), USACERL, and Dr. Roger Schneider of Rho Sigma Associates, Inc., Whitefish Bay, WI. Bernard A. Donahue is Acting Chief, CECER-UL-T, John T. Bandy is Operations Chief, and Gary W. Schanche is Chief, CECER-UL.

LTC David J. Rehbein is Commander and Acting Director of USACERL, and Dr. Michael J. O'Connor is Technical Director.

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# 1 Introduction

## Background

Explosives, propellants, and related munitions are manufactured at a number of U.S. Army installations. The waste generated during the manufacture of these munitions include energetic material waste (EM) and solid waste contaminated with energetic material (EMCW). These wastes must be disposed of in accordance with applicable Federal, state, and local environmental regulations.

For many years open burning (OB) and open detonation (OD) have been used to dispose of energetic wastes because suitable disposal alternatives have not been available. However, OB/OD activities create potential air, water, and soil contamination, which is of increasing concern to environmental regulators. The disposal of EM and EMCW generated from munitions production and demilitarization of outdated ammunition differ in that the demilitarization of munitions with an expired shelf life can be delayed indefinitely. But munitions production can be interrupted if production wastes cannot be disposed of.

The amount of ammunition production EM and EMCW requiring disposal at U.S. Army installations has been unknown. The method most commonly used for determining the amount of energetic wastes generated is to determine the amount of wastes disposed of. Therefore, a study was conducted to determine the rate at which energetic wastes are generated at U.S. Army ammunition production facilities so possible alternative disposal methods can be proposed. The information resulting from the survey has not been available before. It will be of use to U.S. Army policy makers for OB/OD alternatives because it quantifies and qualifies the amount of energetic waste generated at the major OB/OD installations.

## Objectives

The objectives of this study were to determine the amount of munitions production EM and EMCW generated at nine U.S. Army Materiel Command (AMC) installations for the 5-year period 1988 to 1992 and to verify the manner in which these wastes are disposed of.

## Approach

Nine U.S. Army installations involved with munitions manufacture were surveyed by questionnaire to determine the rate of EM and EMCW generated for the 5-year period (1988 to 1992) and the methods used to dispose of these wastes. Each installation was then visited to verify, clarify, and refine the data given on the questionnaire.

## Mode of Technology Transfer

The generation rates for energetic materials in this report will be useful to the policy makers who write AR 200-1 and for the technical requirements for waste disposal in AR 420-47. Information in this report also will be presented in papers given at environmental symposiums and at poster sessions at professional meetings.

## Metric Conversion Factors

1 in.	=	25.4 mm
1 ft	=	0.305 m
1 cu yd	=	0.076 m <sup>3</sup>
1 mph	=	1.61 km/h
1 lb	=	0.454 kg
1 gal	=	3.78 L

## 2 Production Waste EM and EMCW Generation and Disposal: Installation Survey Data

Selected AMC installations were mailed a brief questionnaire to obtain data about the munitions production EM and EMCW generated. The questionnaire requested data on the amount and type of EM and EMCW generated in association with the production of munitions at the installations during the 5-year period from 1988 through 1992. Each facility then was visited to clarify and refine the data provided. The installations do not maintain data in the same manner; therefore, the information from the installations varies. The results of the survey follow.

### Milan Army Ammunition Plant (MAAP)

#### *EM and EMCW Generation*

MAAP, a government owned-contractor operated (GOCO) facility operated by Martin Marietta Corporation, occupies approximately 22,800 acres in the State of Tennessee. Its mission includes load, assemble, and pack (LAP) ammunition and the demilitarization of obsolete, conventional ammunition. LAP operations include 40 millimeter (mm) through 155 mm rounds, bursters, fuses, grenades, ignition cartridges, propelling charges, and miscellaneous other items. The installation generates various EM and EMCW in association with these munitions production operations and demilitarization activities.

MAAP generates basically three types of EM and EMCW that go to OB/OD:

- true production-related wastes that result from the production of ammunition, i.e., byproduct waste;
- propellants that have reached their useful shelf life and cannot be resold or reworked and must be destroyed;
- specific end items that have reached the end of their useful shelf life and must be destroyed.

Table 1 contains the amounts of the various EM and EMCW wastes generated and disposed of through OB and OD activities at MAAP. An examination of the data for

Table 1. MAAP: OB/OD of EM and EMCW (in tons).

	1988	1989	1990	1991	1992
EM (OB) <sup>1,2</sup>	100	79	242	357	355
EMCW (OB) <sup>3</sup>	470	470	470	470	470
EM (OD) <sup>2,4</sup>	55	60	42	16	30
EMCW (OB) <sup>5</sup>	6	9	9	14	7

<sup>1</sup>EM from stores for 1991 and 1992 was about 351 tons annually. This is mostly propellant that has an expired shelf life and is considered demilitarization waste not EM from production. EM explosive weight is without containers.

<sup>2</sup>EM includes the sludges from washdown pits, which are routinely cleaned out.

<sup>3</sup>EMCW burned in south burn pens. These data exclude metal and noncontaminated wood used to support combustion in flashing or burning. This EMCW is production waste. The number 470 is the average over the 5-year period.

<sup>4</sup>EM explosive weight is without containers.

<sup>5</sup>EMCW production waste data from rags and solvents.

1991 and 1992 shows that the amount of EM from demilitarization (the breakdown of rounds and the destruction of obsolete propellant) is approximately 98 percent of the total amount of EM requiring OB and OD. Propellants that have never been incorporated into a munition make up a large amount of these EM figures.

The relatively large amount of EMCW in Table 1 is generated almost exclusively from LAP operations. The EMCW that are decontaminated by open burning or flashed, include metal, wooden boxes, etc. (Flashing is the decontamination of metal and other substances by exposure to the heat of the combustion process.) Wood items are commonly used for the flashing process. The wood may or may not be EMCW.

The rags and solvents EMCW data in Table 1 are based on the weight of rags and solvents taken from the production activities. Rags contaminated only with glue were treated as EMCW at one production line. The workers recognized that the rags with glue were not EMCW; however, they were disposed of as EMCW and not as a solid waste. Solvents are not recycled, apparently because of the relatively small amount of waste solvent generated.

MAAP disposes of an additional 3,411,600 lb of trash each year by OB. This figure is based on data from 1988 through 1992 and is not included on Table 1. Trash burning, such as the OB of EM and EMCW, is approved by the State of Tennessee. MAAP is the only facility to report this type of trash burning data. The OB of trash at MAAP is essentially a volume reduction step prior to ultimate disposal into an onsite landfill.

### **OB Operations**

The OB site is about 95 acres, and burning operations are conducted in several areas. The east area has two burn pads for noncontaminated wastes. The southwest area has nine pans for EM and three pans for EMCW (rags with solvent). The south area has two fenced sections for flashing EMCW. The OB of EM is conducted in the nine above-ground pans (lined) with a capacity of 333 lb each, which yields a total of nearly 3,000 lb per burn. With four burns per day, nearly 12,000 lb (pure EM) is burned each day. Approximately 300 lb of rags contaminated with solvent (EMCW) are burned as a single event each week in the three pans (unlined). Burning normally is conducted daily during the work week; the hours of operations normally are between 0730 and 1630. Burning operations are conducted approximately 180 days per year; this schedule has remained relatively constant over the 5-year period. Wastes are received during rainy weather, but no OB operations are conducted then. The burning of EM is started with an electrical squib. Excelsior is used for EMCW and trash. Fuel oil is added to some of the EMCW but only when in the pans.

Approximately 10 percent of EMCW burned is noncontaminated wood used to flash the explosive-contaminated metal; the ratio of metal to wood is about 10:1. The amount of wood burned is not included in Table 1. Thermopellets are used to verify that adequate temperatures have been reached when flashing metal.

The OB areas have several adjunct facilities to dispose of relatively small amounts of small fuses, primers, and detonators. A small furnace is used 1 or 2 days per month for the disposal of small fuses and detonators. A detonator press for primer deactivation is used approximately 1 week a year. An electric detonator is used for primers approximately once a week.

EM from production lines is stored in one of 14 permitted storage magazines. Rags contaminated with solvent are received in 55-gal 17H steel drums. EM/EMCW is stored in a variety of containers (metal and fiber drums, wooden and cardboard boxes, etc.) throughout the facility's production areas. EMCW also is deposited in yellow dumpsters at various locations throughout the facility. Material for OB is received at the OB area at secure trailers or buildings for OB. The waste goes into storage if it is not burned in 48 hours.

Ash from the burning of EM and EMCW is sampled and analyzed routinely. Approximately 30 percent of the ash is hazardous, usually because of lead (up to 14 to 15 percent), chromium, or cadmium (possibly from flashing). Arsenic also has been a problem. Barium normally is not a problem. Nonhazardous ash is disposed of onsite as a special waste, and hazardous waste ash is disposed of offsite. Ash also is tested

for nitrobodies; if they are found, the ash is reburned. However, this seldom is a problem.

### ***OD Operations***

OD operations are conducted at the ammunition destruction area, which is approximately 115 acres and is divided into two separate subareas. The ammunition destruction area operates approximately 100 days per year. An average of 8 to a maximum of 10 underground shots take place per day. All shots are set up for an average net explosive weight of 350 lb per pit. EM for OD are stored in secure trailers at the explosive waste transfer facility (concrete and gravel area 150 ft x 150 ft with a chain link fence) and go directly to OD from there. Storage time is less than 48 hours because of storage permit conditions.

### ***General***

- The facility has an air permit from the State of Tennessee.
- MAAP has no history of notices of violation (NOV), citations, or fines associated with the OB/OD operations. The current relationship with regulators is rated excellent, and the State of Tennessee is not concerned about the MAAP OB/OD operations.
- MAAP has six industrial wastewater treatment plants (WWTP), three of which are active. Spent carbon is generated as a waste and the Defense Reutilization and Marketing Office (DRMO) handles disposal.
- The OB/OD area has ground water contaminated with cyclotrimethylene-trinitramine (RDX) and trinitrotoluene (TNT). The ground water contamination is being studied by the installation to determine the full nature and extent of contamination.

## **Lake City Army Ammunition Plant (LCAAP)**

### ***EM and EMCW Generation***

LCAAP, a GOCO facility operated by Olin Corporation, occupies 3,962 acres in the State of Missouri. Its mission includes the manufacture of small caliber ammunition and associated explosive and pyrotechnic materials and the demilitarization of selected, obsolete, conventional munitions. LCAAP is currently the only small caliber ammunition production facility within the Department of Defense (DOD). The LCAAP staff includes approximately 1,800 contractors and 40 government employees.

Table 2 contains the amounts of the EM generated and disposed of through OB and the explosive waste incinerator (EWI) at LCAAP from 1988 to 1992. Much of the EM from production was derived from the blending of pyrotechnics and charging pyrotechnics into projectiles, scrap RDX from pelletizing operations and charging pellets into the projectiles, and scrap propellant powder from cleanup operations in the cartridge loading area.

LCAAP currently generates no EMCW that requires disposal by OB/OD or incineration. EMCW generation is minimized. For example, contaminated gloves go to an installation cleaning facility, and propellant 55-gal drums are recycled. This is unique among U.S. Army ammunition plants (AAP) and may support the concept that many AAPs generate too much EMCW.

The demilitarization of munitions is part of the mission of LCAAP. It is limited to items produced at LCAAP that can go through the EWI.

Although routine OB operations are no longer performed at LCAAP, certain nonroutine exceptions require the use of OB, including:

- emergency OB or OD of dangerous items that have no other safe disposal alternative,
- flashing materials by OB to ensure the elimination of potential EM prior to performing maintenance or resale,
- safety and fire training,
- controlled burning of range areas, and
- safety testing.

A WWTP project for pyrotechnics was initiated in the mid 1980's. The WWTP became operational in March 1992. Since then all pyrotechnics scrap goes to the WWTP. This pyro WWTP operates in a batch fashion to treat up to 25 55-gal drums (approximately 1,000 gal) in one batch. Batches of this size are treated about twice a week. The

**Table 2. LCAAP: OB and Incineration of EM (in tons).**

	1988	1989	1990	1991	1992
EM (OB) <sup>1</sup>	8	5	10	11	9
EM (EWI) <sup>2</sup>	35	30	362	428	397

Note: OD operations are used for emergency disposal only.

<sup>1</sup>EM (OB) are production related. Pyrotechnic waste makes up 95 percent of these wastes. After April 1993 all the EM have gone to either the pyro WWTP or the EWI. OB operations have been terminated.

<sup>2</sup>EM from the demilitarization of Class A, B, and C munitions are incinerated in the EWI.



treatment consists of adding nitric acid to acidify the pyrotechnic-containing wastewater to pH 2.5 for 30 minutes to destroy the pyrotechnic, sulfuric acid is added to react with the barium and strontium-creating sulfates, and the batch is neutralized with sodium hydroxide prior to discharge to the sewer. The neutralized solution is fed slowly into the sewer, which goes to the local publicly owned treatment works. The LCAAP has one National Pollutant Discharge Elimination System permit for the entire installation.

The LCAAP also has a neutralized explosive wastewater treatment plant (NEWTP) for the treatment of approximately 18,000 gal of wastewater a day from the production of lead-based initiating explosives. Wastewaters going to this plant are piped from points of generation that have been pretreated in a kill tank to effectively neutralize any explosive before lift station pumping to the NEWTP. Lime is added for heavy metals removal. NEWTP sludges are Resource Conservation and Recovery Act (RCRA) listed hazardous wastes (K046) and go to a hazardous waste landfill offsite. LCAAP also has an industrial wastewater treatment plant. LCAAP no longer operates a sewage treatment plant.

### ***OB Operations***

The OB area is approximately 20 acres and includes an adjacent field for OD, when needed. The pad area has six pans that are unlined and covered. Normally there are two to three OB events per week. The Missouri Department of Natural Resources Burning Permit allowed a maximum of 240 lb of EM to be burned every day, or 480 lb every other day. Usually 240 lb are burned per event. This is total explosive weight. Four pans are ignited with propane burners; the other two pans are ignited with EM wastes. Scrap wood has been added to the EM piles to aid in the combustion.

Although OB is no longer routinely conducted, flashing of metal scrap, parts, and equipment will continue to be performed at the OB facility. The State of Missouri does not consider flashing to be OB. Flashing occurs about 50 times a year, or about once a week.

Scrap pyrotechnic mixes are stored in open-top, 55-gal, lined drums with the lids secured. Scrap propellant powder is stored in 2-gal metal containers with the lid secured. Scrap RDX is stored in a similar manner, and all the containers are labelled. The maximum length of storage is 90 days.

OB ash is tested annually and is a hazardous waste because of barium and lead.

### ***OD Operations***

In emergency situations, OD operations are conducted in a field adjacent to the OB area.

### ***Incineration***

As of April 1992, the EWI has a full RCRA Part B Operating Permit. The EWI operates about 20 hours (2 shifts) each day for 4 days a week for a total of 80 hours weekly. The material that goes through the EWI is mostly small arms and waste propellant. The U.S. Army Environmental Hygiene Agency did the last performance test. Chromium emission levels were of some concern.

### ***EM Reduction Opportunities***

Potential methods to reduce EM include:

- better controls so poor quality propellant and other materials are not accepted, only to have to destroy them later;
- better quality control procedures to ensure that deteriorating EM materials are predicted and that the manufacturer plays a greater role in the ultimate disposition of the materials; and
- more sensitivity about allowing quality EM materials to be recycled.

### ***General***

- The State of Missouri Department of Natural Resources granted several annual air permits for OB to LCAAP. However, two previous permits were granted with the understanding that future air permits would be more difficult to obtain from the state. The installation of the pyro WWTP and the upgrade of the EWI coincided with the approximate time the state was eliminating the variances.
- LCAAP is ahead of most other AAPs regarding elimination of routine OB/OD operations. Progress appears to have been made as a result of LCAAP staff initiatives and factors internal to the installation.
- LCAAP has received no environmental citations. Relationships with regulators are good. There have been some neighbor complaints in the past, which are suspected to be the result of noise events other than OB/OD activities.

## Radford Army Ammunition Plant (RAAP)

### **EM and EMCW Generation**

RAAP, a GOCO facility operated by Hercules Aerospace Corporation, is composed of two parcels of land in the State of Virginia; each parcel is about 5,000 acres. The staff consists of 36 government and 1,670 contract workers. The RAAP mission includes the manufacture of TNT, nitrocellulose (NC), nitroglycerin (NG), and single- and multibased propellants. The current level of activity is relatively low.

RAAP activities generate EM and EMCW from production activities. The primary processes generating EM and EMCW are described briefly below.

**NC Production.** Wood pulp and/or cotton linters are nitrated with a mixture of nitric and sulfuric acid to process NC. The NC is beat into fines, purified by boiling, and washed with a caustic to remove acid. Waste NC from these processes can be incinerated or OB if contaminated (with rocks, metal, or other foreign material).

**NG Production.** Glycerin is nitrated with mixed acid (similar to NC manufacture) to manufacture NG. Waste NG from propellant manufacturing is mixed with sawdust and triacetin, a desensitizing agent, and is incinerated or OB if it is contaminated.

**Propellant Production.** Single- and multibased propellants are manufactured using both the solvent and the solventless processes. Waste or offspec propellant that has been contaminated so it cannot be processed through the grinding step of the waste propellant incinerators is OB.

EMCW includes contaminated lumber from barricades and materials that may be contaminated with NG condensate, barrels with propellant ingredients, and similar materials suspected of being contaminated with EM. Metal flashing also is performed at RAAP. Although the emphasis is on burning only true EMCW, some noncontaminated materials get by the facility operators and are burned.

EM waste is disposed of by either OB or incineration; EMCW is disposed of by OB. OB activities include the use of a large air curtain destructor (ACD) without air pollution emission controls that dispose of only EMCW. OD activities are not conducted. The decision to send a material to OB or incineration is made by the generating production staff. If the material may have metal or other foreign matter, it cannot go through the incinerator and its pretreatment process but will go to OB. If the EM is not considered to be contaminated with metal and is of the proper size, it will go to the incinerator.

Floor sweepings go to the burning grounds for OB. Approximately 60 percent of the EM goes to the incinerator and 40 percent goes to the burning ground.

The amounts of EM and EMCW and their disposition are shown in Table 3.

There is no demilitarization of explosives and propellants at RAAP.

### **OB Operations**

There are three OB areas: (1) the propellant burning grounds for EM and EMCW, (2) a large ACD for EMCW, and (3) the decontamination burning pit for EMCW and flashing large items.

The propellant burning grounds area is next to the river and floods on rare occasions. EM is burned in large clay-lined pans that have a maximum capacity of 1,000 lb each. The pans are covered, on gravel pads, and some are elevated. Yellow carts are available onsite for accumulation of EM waste. Some EMCW also is burned at the propellant burning grounds. Burning occurs each Monday through Friday at 1430, weather permitting. The burning is electrically ignited. Diesel fuel is used to assist the ignition.

The ACD is used to burn EMCW. The ACD is relatively large and has no air pollution controls. Burning occurs Monday through Friday at any time, and there are approximately 250 burn days per year.

The decontamination burning pit is used for OB of EMCW as well as for the flashing of large items. Items that are too large for the ACD go to the pit for OB. EMCW

**Table 3. RAAP: OB and Incineration of EM and EMCW (in tons).**

	1988	1989	1990	1991	1992
EM (OB) <sup>1</sup>	596	337	617	304	324
EM (EWI) <sup>2</sup>	912	633	497	462	242
EMCW (OB)	3,819	558	1,326	3,002	2,292
EMCW (ACD) <sup>3</sup>	1,407	1,633	2,672	1,150	662

**NOTES:**

OD operations are not performed at RAAP. No demilitarization occurs at RAAP.

Metals, surface contaminated wood, and other miscellaneous solid waste comprise the bulk of the EMCW. Approximately 35 percent of this material becomes reclaimed metal.

<sup>1</sup>EM approximate composition is 10 percent NG, 10 percent NC, and 80 percent propellant.

<sup>2</sup>EM (EWI) indicates EM that was incinerated.

<sup>3</sup>ACD reflects the EMCW that was burned in an air curtain destructor.

burning usually occurs only on Friday afternoons. The pit has approximately 50 burn days per year.

EM usually is brought directly to the OB area. The generator of EM decides where its waste will go and places the waste in a 30-gal, yellow, polyethylene trash container. Each container will hold a maximum of 60 lb of EM. Burning grounds operators pick up the waste and transport it to the burning grounds. EMCW is stored in the decontamination burning pit awaiting burning. At the ACD the EMCW is stored under a metal roof on a concrete floor while awaiting burning in the ACD. There are no RCRA permitted storage facilities at RAAP.

Ash from all burning operations and incineration is tested before disposal. The ash can be hazardous or nonhazardous as determined by the toxicity characteristic leaching procedure test, and it is disposed of accordingly. Lead in the ash is a problem from the burning of lead-based propellant. Chromium in the ash also can be a problem. Ash from the EWIs is collected in baghouses.

### ***OD Operations***

RAAP does not conduct OD operations.

### ***Incineration***

At the EWI pretreatment building, the waste containers go on a trolley system and are automatically dumped and conveyed past a metal detection system. If metals are found, a section of the waste is dumped and hand sorted. Water is added to the EM waste stream, then it is sent through a grinder for size reduction. The grinder used for size reduction of the waste was installed in the late 1970s. A water slurry of from 3:1 to 7:1 goes to two 1,800-gal storage tanks and is pumped in a 3 in. line to two nearby EWIs.

Two identical EWIs are fed by a propellant slurry feed line from the grind and slurry operation. Each EWI is approximately 5 ft in diameter and 12 ft long. The design is not a typical ammunition peculiar equipment (APE) 1236 design. Initially the EWI was designed by the Hercules Aerospace Corporation and upgraded over time. The natural gas fired incinerators recently were tested for compliance with RCRA requirements. Control equipment includes baghouse, afterburner, evaporative cooler, and wet-packed column scrubber. Pollutants controlled include particulates and sulfur oxides (through the use of low sulfur fuel).

Waste propellant can be stored for up to 90 days in a converted magazine that serves as a hazardous waste accumulation building prior to going to the EWI facility.

### **General**

- The OB operations do not have an air permit but are registered with the State of Virginia. OB operations are not conducted during either high or low winds. Winds equal to or greater than approximately 15 miles per hour (mph) and equal to or less than 3 mph result in no OB.
- RAAP has been cited by the State of Virginia regulators for OB facilities too close to the plant boundary (less than 100 ft), which is a navigable waterway. This violation has been remedied by administrative controls of the operation. The long-term solution would be cessation of OB at the Propellant Burning Grounds or moving the OB facility.
- The demolition burning pit area and the ACD probably will cause future problems with regulators. The proximity of the burning grounds to the river already is a problem. An RAAP suggestion regarding the construction of a municipal incinerator for RAAP and the surrounding counties' waste was met with local resistance. Pressures on RAAP regarding OB are expected to increase in the future. Air issues may take precedence over RCRA issues.
- A rotating biological contactor WWTP is used to treat the wastewaters from the EM manufacturing processes.

## **Holston Army Ammunition Plant (HAAP)**

### **EM and EMCW Generation**

HAAP, a GOCO facility operated by the Holston Defense Corporation, started operations in 1942; it occupies approximately 6,000 acres in the State of Tennessee. The staff consists of approximately 850 contract and 20 government employees. The HAAP mission includes the manufacture of RDX and cyclotetramethylenetetranitramine (HMX) base explosives (Class A explosives) and explosive products made from RDX and HMX. Production was slightly less in 1992 than in 1991 and may continue at a reduced rate. There are 10 production lines on the installation. The amount of EM and EMCW generated from 1988 through 1992 is shown in Table 4.

The EM generated is composed primarily of RDX, HMX, and products made with RDX and HMX. The EMCW generated is primarily paper, plastic bags, pallets, boxes, liners, piping, and other items potentially contaminated with EM.

Table 4. HAAP: OB of EM and EMCW (in tons).

	1988	1989	1990	1991	1992
EM (OB)	141	121	119	119	70
EMCW (OB) <sup>1,2</sup>	1,088	1,288	1,113	1,375	1,350
NOTE: OD operations are not conducted. <sup>1</sup> EMCW data is based on cubic yards burned and an estimated density of 250 lb per cubic yard. <sup>2</sup> Flashing is not included in these data.					

There is flashing, which is a requirement for some maintenance procedures. Some flashing also is performed in plant areas when necessary. Data on the amount of material flashed are not available.

The amount of EM waste generated was lower in 1992 than in 1991 and previous years for two reasons: (1) the amount of production decreased, and (2) the Holston Defense Corporation initiated a program to reduce EM wastes, which was successful. Improved housekeeping and similar functions also reduced EM waste.

Almost no conventional demilitarization activities are performed at HAAP. When they were done in the past, it was on rare occasions only.

### **OB Operations**

The OB area is approximately 25 acres and has a combination of pans, cages, pads, and flashing area. Two decontamination ovens for flashing are separate from the main OB area.

EM is burned in four pans that are approximately 20 ft × 4 ft × 1 ft, with a capacity of 1,500 lb of EM each. The pans are clay lined and elevated. One or two pans are burned 1 or 2 days a week. Each pan contains from 500 to 1,500 lb when burned. EM waste is delivered to the pans for burning and is covered during rainy or windy weather and at night. Wet waste is allowed to dry for 1 to 7 days before burning. The EM is ignited with an electric starter and excelsior. The periodic burning is relatively clean and generates little ash. The pan area is drained to the WWTP.

EMCW disposal occurs either in piles on pads or in large cages. Large and bulky EMCW is piled and periodically burned on two pads. Each pile contains about 1,700 cu yd of EMCW. The storage time in these piles is less than 90 days. At this survey visit, one pile of EMCW waiting to be burned was about 20 ft high. The two cages are cubes approximately 14 ft on a side and are designed to contain light materials that

might be carried off in the wind. Each cage can hold about 8 to 12 cu yd of EMCW, which is burned 1 to 2 days a week. The OB area is grassy so protection against fire is a concern.

The OB operations do not change with the seasons but occur each week.

Flashing is done in an area in the OB grounds: in one of two decontamination ovens located outside the OB area or in one of the piles of EMCW. One decontamination oven is used principally, and all visible explosive is removed before flashing. Flashing weights for the ovens and OB flashing operations are not available, and summary records are not maintained. The OB flashing area is used about once or twice a month to decontaminate small surfaces with a torch. The primary decontamination oven is used about once a month and is fired with kerosene.

EM waste is collected in plastic bags and transported in trucks to the OB grounds. The EM with water is poured into pans, where it may remain for several days, and the water evaporates. There are no hazardous waste storage facilities at HAAP. Trucks that carry the EM and EMCW wastes can be decontaminated in a washrack area at the entrance to the OB area.

The small amount of ash generated is tested and disposed of as nonhazardous wastes in an on-post landfill.

### ***OD Operations.***

HAAP conducts no routine OD activities.

### ***General***

- EM burning in pans is significantly cleaner and generates less air pollution than EMCW OB.
- An incinerator is being programmed for 1996; however, the exact configuration has yet to be determined.
- Technology is available to separate HMX, RDX, and TNT from EM waste; however, no incentives exist to use it. Approximately 0.5 percent of production goes to the burning ground because it is too costly to clean up.
- No environmental citations have been received by HAAP for operations since 1986. In 1986 an RCRA NOV was received for failure to update hazardous waste training records annually.
- HAAP is not experiencing any real external pressure from the State of Tennessee to stop OB operations.



- The OB site has an air permit from the State of Tennessee with some limitations, including no introduction of offsite material, burning only during daylight, and no burning in the rain.
- EM-contaminated solvents are recycled to include both the solvent and the EM.
- The HAAP area is underlain with red clay like much of the southeastern United States.
- HAAP is interested in aggressively exploring burning EM in a co-combustion process. A HAAP study group also is exploring the potential for composting EM and EMCW.
- The HAAP contractor believes there are many obstacles to inhibit efforts to limit waste generation and the change system, e.g., the reluctance to change military specifications affects potential reuse and recycling of explosives.

## **Lonestar Army Ammunition Plant (LSAAP)**

### ***EM and EMCW Generation***

LSAAP, a GOCO facility operated by Day and Zimmerman Incorporated, is approximately 15,000 acres and is located in the State of Texas. It is adjacent to the Red River Army Depot. The current work force is approximately 1,100. LSAAP's mission includes the LAP of high explosives, pyrotechnics, and propellants. LSAAP production operations, which generate EM and EMCW, include:

- LAP of explosives that generate these wastes as scrap explosive, reject items loaded with explosive, and explosive-contaminated solid waste such as rags, floor sweepings, and packing materials.
- Press loading of explosives such as RDX and plastic bonded explosive compositions that generate scrap explosive and reject items loaded with explosive and explosive-contaminated solid wastes such as rags, floor sweepings, and packing materials.
- LAP (including pelleting) of pyrotechnics, initiating explosives, propellants, black powder, and other related items generate the same type of waste identified here.

In general the amount of EM and EMCW generated has been decreasing since 1990. The amount of EM and EMCW generated from 1988 through 1992 is shown in Table 5.

### ***OB Operations***

The OB area is approximately 40 acres, is located near the middle of the LSAAP, and has 10 pans that can be used to burn either EM or EMCW. The pans are 6 ft x 8 ft x

Table 5. LSAAP: OB/OD of EM and EMCW (in tons).

	1988	1989	1990	1991	1992
EM (OB) <sup>1,2</sup>	11	27	31	13	48
EMCW (OB) <sup>3</sup>	144	167	222	103	75
EM (OD) <sup>1,2</sup>	190	151	344	322	186
Demilitarization <sup>1,4</sup>	101	101	327	284	103

<sup>1</sup>EM and demilitarization are estimated net explosive weights.

<sup>2</sup>On the average, approximately 35 percent of the EM is related to production. This is based on 5 years of data and assumes all demilitarization components are EM.

<sup>3</sup>Flashing is not included in these data, nor is the amount of wood used to aid combustion.

<sup>4</sup>These are the total amounts of demilitarized munitions. These figures are included in the EM and EMCW data.

2 ft, have covers, and are elevated above the ground or concrete. Some pans are lined with refractory for protection against high heat releases. All 10 pans are not used consistently each day when burning occurs. A pan holds approximately 100 lb of EMCW. The amount of EM waste in each pan is limited and may range up to 1,500 lb. TNT, for example, is limited to 3 in. in depth to prevent a fast burn. In many instances EM waste is used as an initiating agent for OB operations. Scrap wood and excelsior aid in the combustion initiation process, and a large stockpile of available scrap is nearby. Nonwaste EM are not used to start or aid in the burning process at the OB site.

A large on-grade burn pad for EMCW and for flashing large items is approximately 10 ft x 60 ft and has a synthetic liner and a leak detection system. A small ACD can dispose of an assortment of EM and EMCW.

OB operations occur on about 130 days a year, with more OB in the summer than the winter. Burning usually occurs from 0900 to 1700.

EM usually is stored in 30 gal containers. A 5 gal container is used for laboratory EM wastes. EM storage container color codings are: red for flammable, yellow with black stripe for the demolition grounds, and blue for pyrotechnics. Bags line the containers. The containers going to the OB grounds are transported from the generation points to a three-sided EM storage building (Building XX-97) at the OB grounds. EM wastes are stored for less than 90 days prior to burning.

Ash from the OB operations is tested prior to disposal. If hazardous, the ash is transported offsite to a hazardous waste landfill.

### **OD Operations**

The OD area is approximately 50 acres and is located just southeast of the middle of the LSAAP. Only EM or demilitarization items are disposed of by OD. No EMCW is disposed of by OD. Demolition activities detonate about 36 holes per day. Each hole is allowed a maximum of 150 lb of EM. However, an average shot consists of 80 lb of waste. EM for OD are stored in eight igloos and can be stored up to 180 days. First in-first out inventory management is used when possible. Containers for storage may be wooden shipping boxes or lined cardboard cartons.

OD operations occur on about 140 days per year.

### **General**

- LSAAP has an air pollution permit from the State of Texas for OB/OD activities. Visible emissions must be no greater than 30 percent for any 5-minute period. The State of Texas is being more analytical in the scrutiny of the OB/OD operations than in previous years and requires the examination of potential emissions and modeling analysis in determining allowable burn rates. The State of Texas does not favor incineration, which may preclude the use of EWI and other incinerator technologies at LSAAP.
- There have been no environmental citations for any OB/OD activities.
- The amount of EM and EMCW materials requiring OB/OD has been decreasing in recent years.
- There are approximately 142 ground water monitoring wells at LSAAP.
- LSAAP is especially interested in composting as an alternative disposal technology. About 100 miles away is a patented Bedminster Process that uses a cement kiln-type design to process biodegradable wastes into compost. Wastes accepted include sewage treatment plant sludge, trash, chicken wastes, municipal trash, etc. The system also utilizes a transportable unit and may be ideal for some of the EMCW generated. Through Texas A&M University, LSAAP is examining the feasibility of using this system.

## **Iowa Army Ammunition Plant (IAAP)**

### **EM and EMCW Generation**

IAAP is a GOCO facility operated by Mason & Hanger-Silas Mason Company. IAAP was started in the early 1940s, consists of approximately 19,000 acres, and is located in Middletown, IA. The staff consists of approximately 30 government and 1,100

contract employees. The primary mission of this plant is to LAP ammunition items, including small boosters, mines, cratering charges, artillery rounds, missile warheads, and cluster bombs.

Production operations that generate EM and EMCW include the manufacture of projectiles, cartridges, antitank warheads, surface to air warheads, antitank and antipersonnel mines, demolition charges, and miscellaneous ordnance components. EM waste includes scrap explosives and propellants and sludges from wastewater treatment operations and the processing of explosives. EMCW includes explosive-contaminated solvents, explosive-contaminated carbon, and other EM-contaminated solid wastes such as paper, plastic, cardboard, and wood. In addition, a small amount of EM is generated by the developmental laboratories.

The EM that is not recoverable for onsite use is sold to approved buyers or treated in the EWI. EMCW- and EM-contaminated metals and equipment are flashed by fire in the contaminated waste processor (CWP) to destroy any remaining EM. OB of EM and EMCW, including the flashing of metals and equipment, is performed on an infrequent basis and requires a variance from the State of Iowa. A deactivation furnace is used to dispose of miscellaneous small EM items.

Table 6 is a summary of production-generated EM and EMCW.

### **OB Operations**

The OB area is approximately 5 acres and has seven pads with pans. The elevated pans vary in size and have covers but no linings. The OB area also has two large baskets for EMCW burning. The area has been used infrequently since December 1982.

**Table 6. IAAP: Incineration of EM and EMCW (in tons).**

	1988	1989	1990	1991	1992
EM (EWI)	61	43	1	9	7
EM (sold) <sup>1</sup>	69	93	123	63	0
EMCW (CWP) <sup>2</sup>	191	235	160	410	345
EMCW (CWP) <sup>3</sup>	334	275	38	80	45

NOTE: OB/OD operations were discontinued in 1992. All figures relate to incineration and sale of EM and EMCW.

<sup>1</sup>EM scrap explosive generated and sold from 1988 through 1991.

<sup>2</sup>EMCW burned in a large CWP.

<sup>3</sup>EMCW that are primarily metal flashing operations which also were conducted in the CWP.

IAAP has been addressing the issue of eliminating OB/OD since the late 1970s. State pressure dates back to 1977 and 1978. IAAP operated under a variance, and finally stopped routine OB/OD when the last variance expired. Several variances have been granted since 1982 for flashing, disposal of EM-contaminated waste, and selected emergency situations.

### ***OD Operations***

The OD area is about 5 acres. Routine OD operations were discontinued on May 28, 1982. OD is performed on an infrequent basis and is limited to ammunition and other items considered to be extremely dangerous and require immediate disposal because of safety considerations. Although emergency OD activities do not require a variance from the State of Iowa, a report of the activity is forwarded to the Iowa Department of Natural Resources.

### ***Incinerators***

IAAP uses a combination of an EWI, a CWP, and a deactivation furnace to dispose of EM and EMCW.

EWI operations started in 1982 at IAAP; it was one of the first in operation by the U.S. Army. The cost of construction of the EWI was about \$1,000,000; and it has an RCRA Part B Permit. The air pollution control equipment includes a gas cooler, cyclone, baghouse, and afterburner. The EWI was used for only 720 hours in 1991 and 1992 because of regulatory driven upgrades, which account for the relatively small amount of EM incineration in those 2 years.

The EM is not considered waste until it is about to enter the incinerator unit because the EM can be offered for sale at any time. The igloos that contain the EM material originally were constructed for explosive items, and therefore meet stringent storage requirements. All ash from the EWI is considered to be a hazardous waste. EWI ash as well as EM-contaminated carbon, sludges, and solvents can be stored in a permitted hazardous waste storage facility. The cost of ash disposal is about \$300 per barrel.

The CWP has been in operation since 1982 and is used for EMCW as well as for flashing. The incineration and flashing occur in large boxes or cages. This CWP is a car bottom unit within a large enclosed structure. Air pollution control equipment includes a gas cooler, cyclone, and baghouse. Contaminated waste is put into plastic bags then into large, dumpster-like containers about 4 cu yd in size. The containers are taken to the CWP for disposal. The CWP generates the largest amount of ash of all the incinerator operations.

The deactivation furnace, or APE 1236, is used for primers, detonators, and fuses on a limited basis. It has a cyclone and baghouse and was used for several days only in 1992. It needs to be upgraded to meet new incinerator standards to operate.

### **General**

- IAAP has received no NOV for any OB/OD activity. The State of Iowa had a major impact over the years in forcing IAAP to institute incineration facilities. This was partly because of the state's view that alternatives to OB/OD exist. IAAP is concerned about the difficulty in obtaining future variances, which may force more enclosed EM/EMCW destruction technologies.
- The IAAP contractor has a progressive mind-set that there are alternatives to OB/OD, which has had a positive influence on reducing OB/OD activity.
- The IAAP contractor believes that greater effort can be made by the U.S. Army to program and facilitate marketing of waste explosives.
- The use of a CWP for EMCW disposal, with its large operations and maintenance requirement, increases scrutiny over what are truly EMCW.
- Area ground water has parts per billion levels of EM contamination. Nearly 200 monitoring wells are to be used to identify the nature and extent of contamination.
- The contractor staff believes that the U.S. Army could do a better job of planning its EM disposal activities, which would allow greater marketing opportunities. The U.S. Army might improve sales if it tried to market its EM rather than attempting to control the terms of the disposal. In addition, a central U.S. Army marketing strategy may prove more effective than having each installation attempt to market its own EM.
- Explosive-contaminated carbon and diatomaceous earth filter media are generated from WWTP operations. Diatomaceous earth filter waste material is burned. Waste-activated carbon is recycled in Zewickel, PA; it is heat regenerated and resized. The waste is shipped from Iowa as a hazardous material and returned as a purchased material.

## **McAlester Army Ammunition Plant (MCAAP)**

### **EM and EMCW Generation**

MCAAP, is a government owned-government operated (GOGO) installation in the State of Oklahoma. Its mission includes the production and renovation of conventional ammunition and ammunition-related components; manufacturing, industrial engineering, and product assurance in support of production activities; and the receipt,

storage, shipment, demilitarization, and disposal of conventional ammunition and related items. Storage space at MCAAP includes 2,200 igloos.

The munitions productions (LAP) activities that generate EM and EMCW are described in the Appendix. Due to the available detailed recordkeeping, a unique and comprehensive description of the LAP activities and their related waste generation are provided.

Regarding the data in the Appendix on production wastes, the weights for scrap are for pure propellant and do not include any wood or other solid waste, unless otherwise indicated. The term scrap propellant usually refers to triple-based propellant.

The data in Table 7 shows that approximately 50 tons per year of production-related EM and EMCW have required disposal by OB/OD. Table 7 also contains data on the amount of demilitarization-generated EM and EMCW requiring disposal by OB/OD, an average of 5,300 tons (gross weight) per year. Based on these data, the amount of production-related EM and EMCW is approximately 1 to 2 percent of the total amount disposed of by OB/OD.

### **OB Operations**

OB/OD operations are not regularly scheduled for production waste because the amount of material generated is not predictable. However, OB/OD operations are regularly scheduled for demilitarization operations. OB occurs on about 200 days a year. More activity takes place in summer than winter. From December to February, the OB operations are in a reduced mode. Meteorological limits on OB/OD include wind levels not to exceed 20 mph, with maximum gusts of 30 mph.

There are five pads with several metal burn pans on each pad. The permitted capacity is 4,000 lb per pad per day. Normally there are two burns 2 days a week for production scrap material. Diesel fuel is sometimes used to help start pallets and

**Table 7. MCAAP: OB/OD of EM and EMCW (in tons).**

	1988	1989	1990	1991	1992
EM <sup>1</sup>	25	29	28	25	45
EMCW	18	18	21	18	21
Demilitarization <sup>2</sup>	5,451	7,619	2,899	3,554	7,129

<sup>1</sup>Production-related EM weights are for pure EM and do not include wood or other solid waste.  
<sup>2</sup>Demilitarization weights include explosives, containers, etc. The amount of explosives can be estimated at approximately 50 percent of these figures.

contaminated wood that is burned in a trench when flashing cans and metal parts.

EM from production operations are stored in the original manufacture or equivalent containers. EMCW is packaged in cardboard containers, such as TNT boxes, and stored in explosive storage magazines until destroyed. There is no separate storage on the OB/OD grounds. Contaminated rags and gloves normally are packed in plastic bags and stored at the burning ground site in a locked building until destroyed.

### ***OD Operations***

The OD area is composed of two demolition pads, one old and one new. Each OD site has 26 pits that are enclosed on three sides and carved into embankments. Although the OD ranges at MCAAP are sited for a maximum of 500 lb of explosive weight per pit, MCAAP maintains a 150 lb per pit limit. The quantities may be less but are not likely to exceed these limits. Donor material for OD is either production scrap or virgin material. OD operations occur on 100 or more days a year. Six-day weeks are common, and detonations occur from 1100 to 1200.

### ***Incinerator***

The inactive APE 1236 deactivation incinerator has operated in the past for several years and is being upgraded.

### ***General***

- MCAAP has not received any NOV associated with OB/OD operations.
- Because of the proximity of the OB/OD facilities to the boundary, consideration is being given to moving the OB/OD operations to a more advantageous location. A perimeter noise monitoring system is in place.

## **Redstone Arsenal**

### ***EM and EMCW Generation***

Redstone Arsenal, located in the State of Alabama, is a U.S. Army Missile Command (MICOM) installation that supports the missions of the National Aeronautical and Space Administration (NASA), Thiokol Corporation (industrial base), MICOM and its propulsion directorate, and U.S. Test and Evaluation Command activities.



Nearly all the EM and EMCW waste generated is production-related waste. The EM and EMCW generated from 1988 through 1992 are shown in Table 8. Most of the waste is propellant waste generated by Thiokol as a result of contract operations in the construction of rocket motors. These operations are not primarily U.S. Army operations. Thiokol produces missiles by contract for the U.S. Army, NASA, the U.S. Air Force, and other contractors who may modify them then sell them to one of the DOD services, a foreign country, or another entity. The propulsion directorate of MICOM and other laboratories on Redstone Arsenal also generate EM and EMCW.

### **OB Operations**

The OB area is relatively small; there is a total of five burn pans, three of which are comparatively new. Hardstand pads under the pans are large and slope away from the burn pans. Pan limits are 100 lb for 1.1 propellant, 2,000 lb for 1.3 propellant, 1,000 lb for contaminated oxidizer (ammonium perchlorate), and 300 gal for contaminated solvent. Propane lighters were installed to start the burning but were ineffective and have been replaced with hay as a fire starter. The pans have pipes to vent water from the propellant; but these vents are no longer used. Scrap lumber is added to aid in the combustion; pallets are preferred. Burning occurs each day at about 0900 and depends on the weather. OB/OD activities are limited by cloud cover and the potential for precipitation. There are about 150 to 200 burning days a year.

EM and EMCW are not transported to the burning grounds until they are ready for disposal. The propellant arrives in bulk in lined 55-gal drums. The contaminated solvent is delivered in 55-gal drums. Much of the EMCW also arrives at the burning grounds in 55-gal drums. The waste normally is disposed of within 90 days. If necessary, the wastes can be stored in one of four approved hazardous waste storage facilities (igloos).

**Table 8. Redstone Arsenal: OB of EM and EMCW (in tons).**

	1988	1989	1990	1991	1992
EM (OB) <sup>1</sup>	188	198	202	150	105
EMCW (OB):					
General	34	55	54	54	48
Solvent	12	3	2	2	6
Oxidizer	7	10	6	12	8

NOTE: EM is primarily disposed of by OB. OD is not listed because it is limited to disposal of sensitive materials, old ammunition, off-spec products, or laboratory-related items.

<sup>1</sup>EM from Thiokol rocket motor production is the bulk of propellants that requires disposal. Explosive weights are listed.

Ash generated from these OB operations normally is tested for metals and explosives. Ash is stored in a permitted igloo prior to final disposal. Metals from the burning operations go to a DRMO for disposal.

### ***OD Operations***

The OD facilities include only five firing points, each with a limit of 25 lb of EM per firing point. OD operations are conducted on approximately 50 days each year. This activity generates little notice or complaints offpost.

### ***General***

- Currently there are no incinerators at Redstone Arsenal.
- One NOV for allowing the ashes of the OB of contaminated solvents to touch the ground was received in the fall of 1992.

## **Crane Army Ammunition Activity (CAAA)**

### ***EM and EMCW Generation***

CAAA, located in the State of Indiana, is GOGO installation and a major tenant of the Crane Naval Surface Warfare Center (NSWC). The Crane NSWC was established in the early 1940s, and CAAA started operations in 1977. (LAP operations were in existence under the Navy prior to 1977.) The NSWC occupies about 63,000 acres; approximately 82 percent is under the control of the CAAA. The CAAA workforce is approximately 550. The mission of the CAAA is to produce and renovate conventional ammunition and ammunition-related components and receive, ship, and/or demilitarize and dispose of conventional and related munitions. The munitions production operations responsible for generating EM and EMCW include the casting of explosives, to include the explosive PBXNO6; press loading of projectiles and boosters; preparation of primers; production of pyrotechnics such as red phosphorus, infrared decoy rounds, illuminating flares, and spotting rounds; and renovation of old rounds (e.g., new propellant addition).

Table 9 is a summary of the production generated EM and EMCW disposed of by OB/OD at CAAA.

Table 9. CAAA: OB/OD of EM and EMCW (in tons).

	1988	1989	1990	1991	1992
EM (OB/OD) <sup>1,2</sup>	4,656	2,349	3,377	3,905	5,936
EM (OB) <sup>3</sup>	-	-	-	108	78
EMCW (OB) <sup>4</sup>	-	-	-	27	61
EMCW (OB) <sup>5</sup>	-	-	-	1,127	-
EMCW (OB) <sup>6</sup>	-	-	-	59	-

<sup>1</sup>EM weight includes both EM and associated munition components.  
<sup>2</sup>EM weight includes waste from demilitarization activities as well as from munitions production.  
<sup>3</sup>EM from munitions production. Data include liquids.  
<sup>4</sup>EMCW from munitions production. Data do not include significant amounts of dunnage used to aid burning.  
<sup>5</sup>EMCW is the amount of dunnage burned at the ABG for 1991.  
<sup>6</sup>EMCW is the amount of dunnage burned at the ORR for 1991.

### OB Operations

The two OB areas operated by CAAA are the ammunition burning grounds (ABG) and the old rifle range (ORR). The ABG occupies approximately 40 acres and is located in a valley. OB operations are conducted in excess of 200 days per year (242 days in 1991). Solid bulk propellant and explosives are burned in 20 pans (14 ft × 7 ft × 1 ft), each with a maximum capacity of 1,500 lb for bulk propellant and 500 lb for explosives. Other pans are used for the thermal treatment of other EM wastes and associated fluids. Dunnage is added to aid in combustion and drive off water. The ABG also has burning cages, a primer pit, and two active dewatering units. There are at least two magazines at the ABG area for temporary storage of EM and EMCW. However, every attempt is made to process the waste material quickly and minimize onsite storage time.

The ORR burning area occupies about an acre and has a surrounding safety zone radius of 1,275 ft. This site has three pits, each with four elevated clay-lined pans, which are 14 ft × 7 ft × 1 ft. Composition D (ammonium picrate) is burned at this site. Burning normally occurs year around between 0800 and 1200.

OB operations are conducted with a varying schedule throughout the year. OB operations are not conducted during periods of low wind (less than 3 mph), high wind (more than 15 mph), precipitation, or under overcast conditions.

Ash from the OB operations is collected and stored temporarily on the facility in a rectangular box with a capacity of approximately 20 cu yd. Ash is disposed of in a

hazardous waste landfill offsite at a cost of approximately \$200 per drum. The ash can contain significant levels of heavy metals, including lead, barium, and chromium.

### ***OD Operations***

The OD area is about 2,500 ft x 1,000 ft and has little vegetation. This hilly area has several ponds at various points downgradient on the perimeter for erosion control. The OD area can accommodate 70 pits. Each pit has a maximum capacity of 500 lb of explosive for a total maximum of 35,000 lb. Normally, only 30 to 40 pits are loaded. OD operations usually are conducted on about 120 days a year from approximately April until November. Operations are not conducted when the ground is frozen or extremely wet. The detonations are performed with timing fuses. Short-term storage is available at the OD site in box cars. No ash is removed; however, metal is recovered for scrap.

### ***General***

- CAAA has not received any NOV's.
- The U.S. Navy has all environmental permits for installation facilities.
- An APE 1236 deactivation furnace to dispose of fuses, detonators, boosters, and small arms cartridges up to 50 caliber is planned for construction after obtaining all environmental permits.
- Wastewater treatment facilities include a main sewage treatment plant, two carbon pretreatment facilities for explosive wastewater, one plating wastewater pretreatment facility, and a lead pretreatment facility (inactive).

### 3 Conclusions

The amount of EM and EMCW generated from munitions production activities are significant. Data over a 5-year period for the nine studied U.S. Army installations showed the total amount of EM and EMCW generated annually were 1,600 and 6,100 tons, respectively.

Although some installations are beginning to use alternative disposal methods, OB/OD continues to be the primary means of disposal. Pressures from some states have resulted in OB/OD activities being reduced in favor of alternative disposal methods such as incineration.

## Acronyms and Abbreviations

AAP	Army ammunition plants
ABG	ammunition burning grounds
ACD	air curtain destructor
AMC	Army Materiel Command
APE	ammunition peculiar equipment
CAAA	Crane Army Ammunition Activity
CWP	contaminated waste processor
DOD	Department of Defense
DRMO	Defense Reutilization and Marketing Office
EM	energetic material waste
EMCW	solid waste contaminated with energetic material
EWI	explosive waste incinerator
GOCO	government owned-contractor operated
GOGO	government owned-government operated
HAAP	Holston Army Ammunition Plant
HMX	cyclotetramethylenetetranitramine
IAAP	Iowa Army Ammunition Plant
LAP	load, assemble, and pack
LCAAP	Lake City Army Ammunition Plant
LSAAP	Lonestar Army Ammunition Plant
MAAP	Milan Army Ammunition Plant
MCAAP	McAlester Army Ammunition Plant
MICOM	U.S. Army Missile Command

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NASA	National Aeronautical and Space Administration
NC	nitrocellulose
NEWTP	neutralized explosive wastewater treatment plant
NG	nitroglycerin
NOV	notice of violation
NSWC	Naval Surface Warfare Center
OB	open burning
OD	open detonation
ORR	old rifle range
RAAP	Radford Army Ammunition Plant
RCRA	Resource Conservation and Recovery Act
RDX	cyclotrimethylenetrinitramine
TNT	trinitrotoluene
USACERL	U.S. Army Construction Engineering Research Laboratories
WWTP	wastewater treatment plants

## **Appendix: Munitions Production Activities at the McAlester Army Ammunition Plant**

1. Cartridge, 20 mm, 4-TP/1-Ap-T, linked.

Description: Install M36A2 primer into M21A1 cartridge case; dispense WC 875 propellant into case; assemble with M95 AP-T projectile and M204 projectile. Link cartridges with M10 links and pack into MK 3 Mods ammunition box.

2. Cartridge, 20 mm, HEI, M210, w/fuse M505A3.

Description: Install M36A2 primer into M21A1 cartridge case, dispense WC 875 propellant into case then assemble with M210 HEI projectile (incendiary mix loaded).

3. Cartridge, 20 mm, 4-HEI/1-AP-T.

Description: Install M36A2 primer into M21A1 cartridge case; dispense WC 875 propellant into case; assemble with M95 AP-T projectiles and M210 HEI projectiles then link with M10 belt links and pack into MK3 Mods ammunition box.

4. Cartridge, 40 mm, HEIP, M162, w/MK 27 PD fuse.

Description: Press composition A-3 pellets; consolidate pellets; paint projectiles; dispense filler E material and tamp; consolidate Comp A-3 pellets into projectiles; install MK 27 fuse; install MK 22 MOD 1 or 2 primer; dispense propellant into case; install lead foil; assemble projectile to case; spray wax on case; clip in box.

5. Charge, propelling, 5 in./38, reduced.

Description: Install MK48 or MK13 primer into steel cartridge case; load case with approximately 3.6 lb of SPDN propellant; install polyurethane plug; load into shipping container and palletize.



6. Charge, propelling, 5 in./54, reduced.

Description: Install MK153 primer into steel cartridge case; load case with approximately 5.93 lb of SPCG propellant; install polyurethane plug; load into shipping container and palletize.

7. Charge, propelling, 5 in./54, MK 67.

Description: Install MK 45 primer into steel cartridge case; load case with approximately 20.7 lb of SPCF propellant; install polyurethane plug; load into shipping container and palletize.

8. Charge, propelling, 5 in./54, MK 73.

Description: Install MK5 primer into steel cartridge case; load with approximately 21.3 lb with SPCG propellant; install polyurethane plug; load into shipping container and palletize.

9. Bomb, 500 lb, MK 82, TP, H-6 loaded.

Description: Disassemble bomb body; coat interior with cavity hot melt; apply thermal coat resin and catalyst to bomb body exterior; batch composition B, D-2 wax, aluminum powder and calcium chloride into H-6; fill bomb with H-6; cap off explosive with polymeric elastomer; finish bomb and palletize.

10. Bomb, 1,000 lb, MK 83, TP, H-6 loaded.

Description: Disassemble bomb body; coat interior with cavity hot melt; apply thermal coat resin and catalyst to bomb body exterior; batch composition B, D-2 wax, aluminum powder, and calcium chloride into H-6; fill bomb with H-6; cap off explosive with polymeric elastomer; finish bomb and palletize.

11. Bomb, 2,000 lb, BLU-109/B, Tritanol loaded.

Description: Disassemble bomb body; coat interior with cavity hot melt; apply top coat paint and color-code band; batch TNT and aluminum powder into Tritonal; pour pellets; tamp load explosive into bomb; cap off with polymeric elastomer; finish bomb and palletize.

12. Bomb, 1,000 lb, BLU-110/B, PBXN-109 loaded.

Description: Disassemble bomb body; coat interior with cavity hot melt; apply thermal coat resin and catalyst to bomb body exterior; batch CXM-7, R45HT, DOA, DHE, A02246, and TPB into PBXN-109; load explosive into bomb; cap off with polymeric elastomer; finish bomb and palletize.

13. Projectile, 16 in./50, HE, MK 145-3, explosive D loaded.

Description: Disassemble projectile body; install nose loading plug; weigh explosive D in increments and press load into projectiles; shape contour and drill nose fuse and base fuse cavities; install base plug and gas check seals, install nose/booster subassembly; paint and stencil; install waterproof protective cap and data card; install grommet and palletize.

14. In addition, these operations generate approximately 10,000 lb of explosive contaminated wood products (EMCW), i.e., ammo boxes, bulk explosive boxes, and pallets.

The generation of EM and EMCW for these operations for the time period 1988 through 1992 follows. The specific operation generating the EM or EMCW is identified by a number corresponding to the operation number. Note that \* denotes EMCW. A summary of these data is shown in Table 7.

YEAR 1988:

11:	Bomb, 2,000 lb, BLU-109/B, Tritonal loaded.	
	Scrap explosive, Tritanol	23,605 lb
	*Tritanol contained rags, gloves, etc.	40 lb
	Catalyst II, MEKP	1,280 lb
12:	Bomb, 1,000 lb, BLU-110/B, PBXN-109 loaded.	
	Scrap explosive, PBXN-109	24,884 lb
	Scrap explosive, CXM7	450 lb
	*PBXN-109 contained rags, gloves, etc.	6,876 lb
*14:	Explosive contained wood products	30,000 lb

YEAR 1989:

2:	Cartridge, 20 mm, HEI, M210, w/fuse M505A3.	
	Scrap propellant	60 lb
4:	Cartridge, 40 mm, HEIP, M162, w/MK 27 PD fuse.	
	Scrap propellant	186 lb
	Comp A-3 scrap	3,392 lb
7:	Charge, propelling, 5 in./54, MK67.	
	Scrap propellant	775 lb
8:	Charge, propelling, 5 in./54, MK 73.	
	Scrap propellant	2,529 lb
11:	Bomb, 2,000 lb, BLU-109/B, Tritonal loaded.	
	Scrap explosive, Tritanol	23,605 lb
	*Tritanol contained rags, gloves, etc.	40 lb
	Catalyst II, MEKP	1,160 lb
12:	Bomb, 1,000 lb, BLU-110/B, PBXN-109 loaded.	
	Scrap explosive, PBXN-109	24,884 lb
	Scrap explosive, CXM7	450 lb
	*PBXN-109 contained rags, gloves, etc.	6,876 lb
*14:	Explosive contained wood products	30,000 lb

YEAR 1990:

4:	Cartridge, 40 mm, HEIP, M162, w/MK 27 PD fuse.	
	Scrap propellant	186 lb
	Comp A-3 Scrap	3,392 lb
5:	Charge, propelling, 5 in./38, reduced.	
	Scrap propellant	218 lb
7:	Charge, propelling, 5 in./54, MK67.	
	Scrap propellant	775 lb
11:	Bomb, 2,000 lb, BLU-109/B, Tritonal loaded.	
	Scrap explosive, Tritanol	23,605 lb
	*Tritanol contained rags, gloves, etc.	40 lb
	Catalyst II, MEKP	1,160 lb
12:	Bomb, 1,000 lb, BLU-110/B, PBXN-109 loaded.	
	Scrap explosive, PBXN-109	24,884 lb
	Scrap explosive, CXM7	450 lb
	*PBXN-109 contained rags, gloves, etc.	6,876 lb

13:	Projectile, 16 in./50, HE, MK 145-3, explosive D loaded.	
	Scrap explosive D	1,450 lb
	*Explosive D contained materials	4,250 lb
*14:	Explosive contained wood products	30,000 lb

YEAR 1991:

7:	Charge, propelling, 5 in./54, MK67.	
	Scrap propellant	75 lb
11:	Bomb, 2,000 lb, BLU-109/B, Tritonal loaded.	
	Scrap explosive, Tritanol	23,605 lb
	*Tritanol contained rags, gloves, etc.	40 lb
	Catalyst II, MEKP	1,160 lb
12:	Bomb, 1,000 lb, BLU-110/B, PBXN-109 loaded.	
	Scrap explosive, PBXN-109	24,884 lb
	Scrap explosive, CXM7	450 lb
	*PBXN-109 contained rags, gloves, etc.	6,876 lb
*14:	Explosive contained wood products	30,000 lb

YEAR 1992:

1:	Cartridge, 20 mm, 4-TP/1-AP-T, linked.	
3:	Cartridge, 20 mm, 4-HEI/1-AP-T.	
	Scrap propellant	1,001 lb
6:	Charge propelling, 5 in./54, reduced.	
	Scrap propellant	132 lb
7:	Charge, propelling, 5 in./54, MK67.	
	Scrap propellant	75 lb
9:	Bomb, 500 lb, MK 82, TP, H-6 loaded.	
	Scrap explosive, H-6	15,000 lb
10:	Bomb, 1,000 lb, MK 83, TP, H-6 loaded.	
	Scrap explosive H-6	21,000 lb
11:	Bomb, 2,000 lb, BLU-109/B, Tritonal loaded.	
	Scrap explosive, Tritanol	23,605 lb
	*Tritanol contained rags, gloves, etc.	40 lb
	Catalyst II, MEKP	1,160 lb
12:	Bomb, 1,000 lb, BLU-110/B, PBXN-109 loaded.	
	Scrap explosive, PBXN-109	24,884 lb
	Scrap explosive, CXM7	450 lb

	*PBXN-109 contained rags, gloves, etc.	6,876 lb
	Catalyst II, MEKP	240 lb
	Catalyst II, MEKP contained rags, etc.	240 lb
	Trichloroethane III	320 lb
13:	Projectile, 16 in./50, HE, MK 145-3, explosive D loaded.	
	Scrap explosive D	1,450 lb
	*Explosive D contained materials	4,250 lb
*14:	Explosive contained wood products	30,000 lb

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